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NASA/SP—1999—7037/SUPPL394  
February 19, 1999

# **AERONAUTICAL ENGINEERING**

A CONTINUING BIBLIOGRAPHY WITH INDEXES



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# Typical Report Citation and Abstract

- ① 19970001126 NASA Langley Research Center, Hampton, VA USA
- ② Water Tunnel Flow Visualization Study Through Poststall of 12 Novel Planform Shapes
- ③ Gatlin, Gregory M.; NASA Langley Research Center, USA Neuhaert, Dan H.; Lockheed Engineering and Sciences Co., USA;
- ④ Mar. 1996; 130p; In English
- ⑤ Contract(s)/Grant(s): RTOP 505-68-70-04
- ⑥ Report Note(s): NASA-TM-4663; NAS 1.15-4663; L-17418; No Copyright; Avail: CASI, A07; Handcopy: A02; Microfiche

⑦ To determine the flow field characteristics of 12 planform geometries, a flow visualization investigation was conducted in the Langley 16- by 24-Inch Water Tunnel. Concepts studied included flat plate representations of diamond wings, twin bodies, double wings, cutout wing configurations, and serrated forebodies. The off-surface flow patterns were identified by injecting colored dyes from the model surface into the free-stream flow. These dyes generally were injected so that the localized vortical flow patterns were visualized. Photographs were obtained for angles of attack ranging from 10° to 50°, and all investigations were conducted at a test section speed of 0.25 ft per sec. Results from the investigation indicate that the formation of strong vortices on highly swept forebodies can improve poststall lift characteristics; however, the asymmetric bursting of these vortices could produce substantial control problems. A wing cutout was found to significantly alter the position of the forebody vortex on the wing by shifting the vortex inboard. Serrated forebodies were found to effectively generate multiple vortices over the configuration. Vortices from 65° swept forebody serrations tended to roll together, while vortices from 40° swept serrations were more effective in generating additional lift caused by their more independent nature.

- ⑧ Author
- ⑨ *Water Tunnel Tests; Flow Visualization; Flow Distribution; Free Flow; Planforms; Wing Profile-; Aerodynamic Configurations*

## Key

- 1. Document ID Number, Corporate Source
- 2. Title
- 3. Author(s) and Affiliation(s)
- 4. Publication Date
- 5. Contract/Grant Number(s)
- 6. Report Number(s); Availability and Price Codes
- 7. Abstract
- 8. Abstract Author
- 9. Subject Terms

# AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 394)

FEBRUARY 19, 1999

## 01 AERONAUTICS

19990014353 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France  
Aerospace 2020, Volume 3, Background Papers. *Aéronautique et Espace à l'Horizon 2020, Volume 3*  
Aerospace 2020, Sep. 1997; 148p; In English; Also announced as 19990014354 through 19990014383  
Report No.(s): AGARD-AR-360-Vol-3; ISBN-92-836-1059-8; Copyright Waived; Avail: CASI; A07; Hardcopy: A02; Microfiche

Volume III is comprised of the technical papers supporting the report of the NATO Advisory Group for Aerospace Research and Development (AGARD) study: "Aerospace 2020". This study explored the most advanced technologies, relevant to aerospace, being researched and developed in laboratories today. The study focused on the most promising current technologies and the organizational and tactical consequences they will have at the field and system levels, over the course of the next 25 years. Topics include: a discussion of the impact of proliferation, human-machine interaction, synthetic environments, directed-energy weapons, information technologies, unmanned tactical aircraft, suborbital launchers, hypersonic missiles, and a discussion of affordability issues. Technologies are assessed from the viewpoints of both potential capabilities and threats. Observations and recommendations are presented. Volume II contains the conclusions of the report. Volume I is a short summary of these conclusions.

Author  
*Aerospace Engineering; Technology Assessment; Fluid Dynamics; Mission Planning; Aircraft Design; Weapon Systems; Hypersonic Aircraft; Human Factors Engineering; Man Machine Systems*

## 02 AERODYNAMICS

*Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces, and internal flow in ducts and turbomachinery*

19990014170 NASA Langley Research Center, Hampton, VA USA  
Drag Measurements on Equivalent Bodies of Revolution of Six Configurations of the Convair MX-1964 (Originally MX-1626) Proposed Supersonic Bomber  
Hall, James Rudyard, NASA Langley Research Center, USA; 1965; 28p; In English  
Report No.(s): NACA-RM-SL53K04; L-82024; No Copyright; Avail: CASI; A03; Hardcopy: A01; Microfiche

Tests on equivalent bodies of revolution of six configurations of the Consolidated Vultee Aircraft Corporation proposed supersonic bomber (Convair MX-1964) have indicated that it is possible to reduce the drag of the configuration by designing it to have a favorable area distribution. The method of NACA RM L53122c to predict the peak pressure drag of a configuration on the basis of its area distribution gave generally good agreement with the subject models.

Author  
*Supersonic Aircraft; Bomber Aircraft; Aerodynamic Characteristics; Bodies of Revolution; Delta Wings; Drag Reduction; Drag Measurement; Aerodynamic Coefficients; Aerodynamic Configurations*

19990017653 National Aerospace Lab., Tokyo, Japan  
Evaluation of STOIL Approach and Landing of the Quiet STOIL Experimental Aircraft "ASKA"  
Nakamura, M., National Aerospace Lab., Japan; Terui, Y., National Aerospace Lab., Japan; Dec. 1997; 24p; In Japanese; Portions of this document are not fully legible  
Report No.(s): PB99-108938; NAL-TR-1341; Copyright Waived; Avail: Issuing Activity (Nat'l Technical Information Service)

(NTIS), Microfiche

The quiet STOL, experimental aircraft 'ASKA' was developed by the National Aerospace Laboratory (NAL) and flight tests were conducted at Gifu airfield between April 1, 1986 and March 31, 1989. This report describes the flight evaluation of STOL approach and landing problems.

NTIS

*Short Takeoff Aircraft; Flight Tests; Research Aircraft; Flight Characteristics; Aerodynamic Configurations; Landing*

### 03

## AIR TRANSPORTATION AND SAFETY

*Includes passenger and cargo air transport operations, and aircraft accidents.*

19990014358 Advisory Group for Aerospace Research and Development, Flight Vehicles Panel, Neuilly-Sur-Seine, France  
Future Transport Aircraft (FTA): Tactical Transport Intermediate Range

Wieland, Klaus, Advisory Group for Aerospace Research and Development, France; Aerospace 2020, Sep. 1997; Volume 3, pp. 35-39. In English. Also announced as 19990014353; Copyright Waived. Avail: CASI, A01, Hardcopy, A02, Microfiche

The report begins with a general discussion of existing tactical aircraft and a look into the necessary design characteristics of the next generation tactical airlifter. In section 2, the main elements in the development of the future European tactical air lifter are presented. These elements are comprised of: (1) the application of carbon reinforced plastics for the wing primary structure; (2) development of a turboprop engine for cruise speeds up to  $M=0.72$ ; (3) aerodynamic design and propeller/wing integration; (4) application of a modern Electronic Flight Control System (EFCS); and (5) autonomous and silent high precision navigation and landing.

CASI

*Transport Aircraft; Turboprop Engines; Aerodynamic Configurations; Flight Control*

### 04

## AIRCRAFT COMMUNICATIONS AND NAVIGATION

*Includes digital and voice communication with aircraft, air navigation systems (satellite and ground based), and air traffic control.*

19990014323 Old Dominion Univ., Dept. of Computer Science, Norfolk, VA USA

Data Link Performance Analysis for LVLASO Experiments. Final Report, 1 Jun. - 30 Sep. 1998

Mukkamala, Ravi, Old Dominion Univ., USA, Dec. 1998; 46p. In English

Contract(s)/Grant(s): NAG1-2102

Report No.(s): ODU-182961; No Copyright. Avail: CASI, A03, Hardcopy, A01, Microfiche

Low-visibility Landing and Surface Operations System (LVLASO) is currently being prototyped and tested at NASA Langley Research Center. Since the main objective of the system is to maintain the aircraft landings and take-offs even during low-visibility conditions, timely exchange of positional and other information between the aircraft and the ground control is critical. For safety and reliability reasons, there are several redundant sources on the ground (e.g., ASDE, AMASS) that collect and disseminate information about the environment to the aircrafts. The data link subsystem of LVLASO is responsible for supporting the timely transfer of information between the aircrafts and the ground controllers. In fact, if not properly designed, the data link subsystem could become a bottleneck in the proper functioning of LVLASO. Currently, the other components of the system are being designed assuming that the data link has adequate capacity and is capable of delivering the information in a timely manner. During August 1-28, 1997, several flight experiments were conducted to test the prototypes of subsystems developed under LVLASO project. The background and details of the tests are described in the next section. The test results have been collected in two CDs by FAA and Rockwell-Collins. Under the current grant, we have analyzed the data and evaluated the performance of the Mode S datalink. In this report, we summarize the results of our analysis. Much of the results are shown in terms of graphs or histograms. The test date (or experiment number) was often taken as the X-axis and the Y-axis denotes whatever metric of focus in that chart. In interpreting these charts, one need to take into account the vehicular traffic during a particular experiment. In general, the performance of the data link was found to be quite satisfactory in terms of delivering long and short Mode S squitters from the vehicles to the ground receiver. Similarly, its performance in delivering control messages from the ground control to the vehicles (aircrafts) was also satisfactory. The report is organized as follows. In Section 2, we describe the background information for the LVLASO and the system flight experiments. Section 3 contains formats of the performance data that was analyzed during our research. Sec-

tion 4 describes different experiments flight experiments and their setup. Section 5 analyzes each of the graphs produced in this report. Finally, Section 6 has a summary of observations that we make based on our research.

Author

*Data Links; Performance Tests; Experimentation; Reliability Analysis; Prototypes; Landing Aids; Ground Based Control; Aircraft Landing*

19990014364 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France  
Low Cost Inertial Systems

Cunningham, T., Advisory Group for Aerospace Research and Development, France; Aerospace 2020, Sep. 1997; Volume 3, pp. 62-63; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

The advent of the Global Positioning System (GPS) has changed the rules for inertial navigation to a significant degree. By the year 2020 the role of inertial sensors will be as aiding and backup to satellite navigation derived data. Traditional inertial instruments error budgets will, in many instances, be relaxed by at least two orders of magnitude in non-jamming environments. The commercial market, driven by requirements in the automotive electronics area, is expected to provide both accelerometers and gyros at very low cost. Many promising concepts are emerging for low cost inertial components and systems, with accuracy sufficient for a broad spectrum of military applications. These include innovative approaches such as silicon-based Microelectromechanical Systems (MEMS) technology.

Author

*Microelectromechanical Systems; Inertial Navigation; Gyroscopes; Military Technology*

19990014477 Colorado Univ., Boulder, CO USA

Experimental Verification of Ocean Bounced GPS Signals and Analysis of their Application to Ionospheric Corrections for Satellite Altimetry

Axelrad, P., Colorado Univ., USA; Cox, A. E., Colorado Univ., USA; Crumpton, K. S., Colorado Univ., USA; 1997; 26p; In English

Contract(s)/Grant(s): NGTI-52139; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

An algorithm is presented which uses observations of Global Positioning System (GPS) signals reflected from the ocean surface and acquired by a GPS receiver onboard an altimetric satellite to compute the ionospheric delay present in the altimeter measurement. This eliminates the requirement for a dual frequency altimeter for many Earth observing missions. A ground-based experiment is described which confirms the presence of these ocean-bounced signals and demonstrates the potential for altimeter ionospheric correction at the centimeter level.

Author

*Global Positioning System; Ocean Surface; Ionospheric Propagation; Satellite Altimetry; Atmospheric Correction; Signal Reflection; Calibrating*

## 05

### AIRCRAFT DESIGN, TESTING AND PERFORMANCE

*Includes aircraft simulation technology.*

19990014356 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France  
Pilot Testing in Virtual Environments

Weeks, Joseph L., Advisory Group for Aerospace Research and Development, France; Siem, Frederick M., Advisory Group for Aerospace Research and Development, France; Aerospace 2020, Sep. 1997; Volume 3, pp. 11-12; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

In the 1980's, applicants to undergraduate pilot training were tested on verbal and quantitative achievement while seated at a desk with pencil and paper. In this decade, applicants are also tested on information processing performance and psychomotor performance while seated at a personal computer with joy sticks and a keypad. By 2020, applicants to undergraduate pilot training, could don goggles and data gloves and enter a virtual environment for the measurement of leadership and team work. Major improvements in pilot testing have been achieved by augmenting the measurement of verbal and quantitative achievement with the measurement of information processing and psychomotor performance. A large evidentiary basis has been established to demonstrate that pencil and paper selection tests measure the abilities important for piloting an aircraft. The addition of measures of information processing and psychomotor performance increment the validity of pencil and paper testing by more than fifty percent.

The next major improvement in pilot testing could be accomplished by the measurement of leadership and team work by using virtual reality computer technology.

Author

*Pilot Training; Performance Tests; Virtual Reality; Psychomotor Performance; Information Processing (Biology); Leadership*

19990014359 Advisory Group for Aerospace Research and Development, Flight Vehicles Panel, Neuilly-Sur-Seine, France  
Rotorcraft 2020

Blake, Bruce B., Advisory Group for Aerospace Research and Development, France; Tischler, Mark B., Advisory Group for Aerospace Research and Development, France; Aerospace 2020, Sep. 1997; Volume 3, pp. 40-43; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Rotorcraft have played a key role in all recent conflicts, as witnessed by use of AH-64's in the opening days of the Gulf War to neutralize Iraqi border defense, and the continuing rotorcraft role in regional conflicts including Somalia, Iraq and Bosnia. Emerging rotorcraft systems coming on-line in the NATO countries during the coming decade include the Comanche, Tiger, NH-90, EH101, and V-22. These systems will exhibit improved capabilities in weapons integration, all-weather operations, and will have increased performance and agility. Future systems envisioned for the 2020 timeframe will make full use of active control technology and smart structures to reduce noise and vibration and increase agility in a care-free maneuvering vehicle. Advances in avionics and GPS technology will be integrated in an advanced glass cockpit that allows for increasingly accurate navigation and weapons delivery in all weather conditions with a tolerable pilot workload. Increased use of integrated modular avionics architecture will improve mission reliability, facilitate maintenance and improve supportability. Further, the full use of unmanned air vehicle (UAV) technologies in a combined manned-unmanned force structure will dramatically improve mission effectiveness without exposing the pilots to unnecessary risks in hostile territory. This paper explores the vision for future rotorcraft technologies as an important component of AGARD Aerospace 2020.

Author

*Rotary Wing Aircraft; Technology Assessment*

19990014376 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France

Required R and D in Airframe Structures and Materials for Combat Aircraft

Olsen, James J., Advisory Group for Aerospace Research and Development, France; Aerospace 2020, Sep. 1997; Volume 3, pp. 108-115; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

This paper compiles and interprets requirements from several sources in the USA for Required R&D in Airframe Structures and Materials for Combat Aircraft. The paper covers: (1) The processes of developing requirements; (2) Previous studies, sources of the requirements; (3) Required R&D; and (4) Some ideas on collaboration within the laboratories, aerospace industry and possibly NATO.

Author

*Aircraft Structures; Fighter Aircraft; Research and Development; Airframe Materials; Structural Design*

19990014378 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France

Integrated Airframe Design Technology

Sensburg, Otto, Advisory Group for Aerospace Research and Development, France; Aerospace 2020, Sep. 1997; Volume 3, pp. 119-120; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Integrated Airframe Design Technology is an important element of a number of activities required to improve the business performance of Aircraft companies worldwide. The customers require more reliable products at an affordable price that perform to specification and are easy to support in service. The time required to design and build an aircraft needs to be reduced and also an environment created whereby all parties involved can work together to influence the development of the design at an early stage. This approach coupled with enhanced visualization and simulation of both the functional and physical elements of the product design will enable modifications to be implemented as part of the design process before the start of manufacturing/build. Thus the need for changes to be carried out during and after production build will be significantly reduced and will result in impressive savings in costs. Integrated Airframe Design Technology provides the basis for this new environment to be developed.

Derived from text

*Airframes; Systems Integration; Design Analysis; Aircraft Design*

19990014350 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France

*Maintenance-Free Aircraft*

Welburn, Steve, Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, pp. 126-127; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Although the ultimate aim of a maintenance-free aircraft may never be achieved, the Aerospace 2020 report highlights the huge cost savings that would result from a substantial reduction in aircraft maintenance costs. The route to achieve these savings has to be via the correct specification of reliability targets for the next generation of aircraft procurement. In particular, reliability throughout the complete mission should be specified as a prime operational performance characteristic of new equipment as it is the ultimate verification of the effectiveness of any weapon system. However, as new equipment to meet new missions becomes increasingly complex, the specification of mission reliability, and the subsequent assurance that the required reliability has been delivered, becomes extremely difficult. Life Cycle Costs (LCC) need to be addressed from the earliest days of a project, in feasibility studies, and followed through into the design and acquisition stage since 90% of LCC may be determined by the decisions made before production of a new weapon systems begins. This paper highlights the emphasis now being placed on maintenance free operating periods for aircraft rather than the traditional approach of assessing mean time between failures for individual equipment.

Derived from text

*Aircraft Maintenance; Cost Reduction; Life Cycle Costs; Weapon Systems; Aircraft Design*

19990014381 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France

*Ageing Aircraft*

Sampath, Sam G., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, pp. 128-130; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Aging Aircraft concerns have dramatically escalated in military and civilian quarters alike during the past few years. The percentage of aircraft that are being operated beyond their design lives is ever increasing. As of 1993, approximately 51% of the aircraft fleet in the US Air Force (USAF) was over 15 years old and 44% was over 20 years old. Yet, some aircraft models that have already served NATO for 30 years or more may need to be retained for another two decades. Due to NATO's changing role which includes peace keeping missions remote from home bases, the requirement of unimpaired high operational capacity, higher utilization of its air fleets, and budgetary stringency's, prospects are for aging aircraft problems to continue to become more acute. Aging Aircraft has several connotations. Among them: (a) technological obsolescence, (b) system upgrades, (c) changing mission requirements unanticipated during design specification and development, (d) the spector of runaway maintenance costs, (e) decreased safety, (f) impairment of fleet readiness, (g) unavailability of home depot facilities. If there is one common denominator among these connotations it is that the cost of operating aging aircraft can be very high. However, technical solutions will be available to fleet managers to deal with the problem of aging aircraft in 2020.

Derived from text

*Military Aircraft; Aging (Biology); Service Life; Cost Estimates; Long Term Effects*

19990014383 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France

*Smart Structures and Materials in Aerospace Applications of Next Generation*

Boller, Christian, Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, pp. 133-140; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A02, Hardcopy; A02, Microfiche

Development in disciplines such as sensing technology, computation, control, micromechanics, materials including processing and many others have made significant progress during the past decades. This progress has been mainly possible through an in-depth analysis of the different aspects in these disciplines, to consequently take more advantage of this progress a synergy between these different disciplines has to be established, resulting in what has been termed to be smart materials and structures. Smart (alternatively; active, adaptive, multifunctional or intelligent) materials and structures is, briefly explained, the integration of sensing and actuation elements into a structure or even more ambitiously into a material, with sensor actuator being linked by a controller. Materials actually favored for integration include optical fibers and piezoelectric materials with respect to sensors, piezoelectric/electrostrictive materials, shape memory alloys and electro-rheological fluids with respect to actuators and microprocessors, neural networks, fuzzy logic and various types of signal processing with respect to control. Since performance of aircraft

and spacecraft has progressed in a sequence of steps in the past, smart materials and structures technology can thus be considered to be the next step in enhancement.

Author

*Smart Structures; Systems Integration; Smart Materials; Structural Engineering; Aerospace Engineering*

19990017726 National Aerospace Lab., Amsterdam, Netherlands

*Uniaxial and Biaxial Tests on Riveted Fuselage Lap Joint Specimens: Final Report*

Vlieger, H., National Aerospace Lab., Netherlands; Otten, H. H., National Aerospace Lab., Netherlands; Oct. 1998; 66p; In English

Contract(s)/Grant(s): MoC AIA/CA-S2-3-2

Report No.(s): PB99-114530; NLR-CR-97319L; DOT/FAA/AR-98/33; No Copyright; Avail: CASI; A04; Hardcopy; A01; Microfiche

As a part of a collaboration program between the Federal Aviation Administration (FAA, USA) and the Department of Civil Aviation (RLD, the Netherlands), the Dutch National Aerospace Laboratory (NLR) has carried out fatigue tests on riveted lap joint specimens. The specimens are representative of the longitudinal lap joints of a commercial aircraft in which multiple-site damage (MSD) was found in service. Two different rivet configurations, dimpled and countersunk riveted joints, were investigated. The countersunk riveted specimens were bonded as well. Four different bonding qualities ranging from fully bonded to fully unbonded were tested. The results of the test program showed that the fatigue life until failure of the dimpled lap joint specimens was about one-quarter of that of the unbonded countersunk specimens. The bonding quality is a major parameter for the fatigue life. Fully or partly bonded specimens did not show fatigue cracking within 500 or even 1000 kilocycles. Specimens with a fully degraded bonding layer have slightly better fatigue properties compared to fully unbonded specimens.

NTIS

*Riveted Joints; Lap Joints; Fuselages; Stress Analysis; Fatigue Tests;*

19990017760 Northrop Grumman Corp., Military Aircraft Systems Div., El Segundo, CA USA

*Enhanced Reliability Prediction Methodology for Impact Damaged Composite Structures: Final Report*

Kan, H. P., Northrop Grumman Corp., USA; Oct. 1998; 100p; In English

Contract(s)/Grant(s): NAS1-19347

Report No.(s): PB99-114548; DOT/FAA/AR-97/79; No Copyright; Avail: CASI; A05; Hardcopy; A02; Microfiche

A thorough review of the existing impact test data and analysis methods was conducted and the results were used to identify a reliability prediction methodology for further development. The integrated residual strength/reliability method developed by Northrop Grumman under a Navy/Federal Aviation Administration sponsored program was selected and modified. The modification was primarily in reducing the number of empirical for the strength prediction. A structural damage tolerance evaluation was conducted using the modified model and the results compared to those obtained from the existing model.

NTIS

*Composite Structures; Structural Reliability; Impact Damage; Reliability Analysis; Prediction Analysis Techniques; Impact Tests*

19990017764 Naval Postgraduate School, Monterey, CA USA

*A Second Law Approach to Aircraft Conceptual Design*

Gleeson, David A.; Sep. 1998; 72p; In English

Report No.(s): AD-A356093; No Copyright; Avail: CASI; A04; Hardcopy; A01; Microfiche

With advancements in the fields of propulsion, aerodynamics, structures, materials and controls, the routine exploration of hypersonic, atmospheric flight has become a more feasible concept. Thus, there is a need for efficient and effective hypersonic configurations. Current studies in configuration efficiency and effectiveness seem to be concentrated in aircraft subsystem design, especially propulsion systems, rather than at the conceptual aircraft system design level. This thesis attempts to initiate the process of incorporating the Second Law of Thermodynamics into the conceptual aircraft design process. The methodology for this process involves the use of the thermodynamic variable energy, also known as availability. The ultimate goal of the process introduced by this thesis is to be able to define an aircraft configuration design space based upon both the First and Second Laws of Thermodynamics.

DTIC

*Aerothermodynamics; Hypersonic Flight; Aircraft Design; Design Analysis; Research; Aerodynamic Configurations; Aircraft Configurations*

## AIRCRAFT INSTRUMENTATION

*Includes cockpit and cabin display devices, and flight instruments.*

19990014367 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France  
Advanced Information Processing and Display Technologies

Timmers, H., Advisory Group for Aerospace Research and Development, France; Helps, K., Advisory Group for Aerospace Research and Development, France; Aerospace 2020, Sep. 1997; Volume 3, pp. 68; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

These technologies: High speed processing, flat panel high resolution displays, voice activation, optical processing/networking, and helmet mounted displays; are mainstream enabling technologies for today's aircraft and/or aircraft now in development. It is not expected that the performance of subsystems based on them will be of adequate performance to cope with increased information availability, 24-hour availability and higher performance sensors. Specifically: High speed processing improvements, deriving from commercial components, will need to be available for increased data processing. Flat panel (color) high resolution displays in large sizes, eg. 30" x 12" will need to be adapted from, e.g. low cost field emission displays (FEDs) developed for commercial reasons in different aspect ratios, to provide an effective means for pilot situation awareness. Voice activation will allow the pilot to operate on a broader front with displays and controls, in high workload or high-g environments, and the military requirements will not be totally covered by commercial developments, e.g. in voice environment robustness. Optical processing/networking is an enabling technology for integrated modular avionics. Helmet mounted displays technology is still deficient in performance, head weight, integration with designation and head down displays.

Derived from text

*Display Devices; Voice Control; Optical Data Processing; Helmet Mounted Displays*

19990014369 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France  
Fault Tolerant Highly Integrated Avionics Architectures

Timmers, H., Advisory Group for Aerospace Research and Development, France; Ott, L., Advisory Group for Aerospace Research and Development, France; Aerospace 2020, Sep. 1997; Volume 3, pp. 73-74; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Avionics is approaching 40% of the weight and cost of the aircraft. In order to reduce weight, cost and maintenance actions and provide affordably increased functionality, a highly integrated commercial-off-the-shelf (COTS) based avionics architecture must be developed. This architecture will be characterized by its modularity, resource sharing, fault tolerance attributes and wide use of commercial components. The overall dependability and fault tolerance of the next generation of highly integrated, COTS based avionics systems will be a critical factor in the effectiveness of those systems in future combat scenarios. Thus the challenge is to demonstrate and validate that this high integration and the military real-time, fault tolerant and security requirements can be met with CTS/open system components.

Derived from text

*Avionics; Systems Integration; Aircraft Instruments; Military Technology*

## AIRCRAFT PROPULSION AND POWER

*Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors, and onboard auxiliary power plants for aircraft.*

19990014382 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France

*Engines*

Leconte, Jean-Pierre, Advisory Group for Aerospace Research and Development, France; Aerospace 2020, Sep. 1997; Volume 3, pp. 131-132; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Because of the high acquisition cost of military aircraft and the diminishing resources for new equipment acquisitions, many aircraft from NATO nations are likely to be kept in service longer than originally intended. The task of achieving life extension while ensuring the high levels of safety and reliability established in the past, will present formidable challenges. From the time an aircraft is put in service, components from both the airframe and engine(s), undergo a process of damage accumulation which

may take many forms and is influenced by usage severity. The long term effects of service induced damage are not always well understood, nor are they well documented, particularly for high time vehicles. The damage can affect both the performance and structural integrity of airframe and engine components. Designers and operators alike need to take into consideration this aging process for ensuring continued safety and reliability of the vehicles.

Derived from text

*Aircraft Engines; Engine Parts; Long Term Effects; Aging (Biology); Service Life*

## 08

### AIRCRAFT STABILITY AND CONTROL

*Includes aircraft handling qualities; piloting; flight controls; and autopilots.*

19990014360 Advisory Group for Aerospace Research and Development, Flight Vehicles Panel, Neuilly-Sur-Seine, France  
Reconfigurable Flight Control at Wright Laboratory

Chandler, P. R., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, pp. 44-47; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Various government departments, including USAF Wright Laboratory, Naval Air Development Center, NASA, and ARPA are sponsoring the development of reconfigurable flight control systems. The reconfigurable system detects and compensates for in-flight failures and damage to maximize handling qualities and performance. Considerable success has been achieved to date. Some concepts have had limited flight tests, numerous piloted simulations have been performed on a range of aircraft, and lower risk portions of the technology have been transitioned to production A/C. The full benefit of reconfigurable flight control is just now being uncovered. Reconfigurable control is a subset of nonlinear or adaptive control. Compensating for large discrete events pays handsome benefits in survivability, fault tolerance, and safety of flight. Expansion of limited reconfiguration to a more fully adaptive approach pays even greater dividends. Such an approach will lead to faster development, reduced development costs, significantly less simulator tuning, a high degree of robustness to modeling errors and changes, and easy extensibility to new configurations and models. The technologies key to achieving these benefits are real-time parameter IDentification (ID), on-line control design, control allocation, and command limiting. Work to date has concentrated on Failure Detection, Isolation, and estimation (FDIE), and control power redistribution. These techniques generally involve extensive off-line development and are heavily model dependent. Due to the effort involved, the reconfiguration capability is limited. A full ID and on-line design approach is highly adaptive. However, the technology is not yet available to field a fully adaptive flight control system today with acceptable risk. In particular, the ID must be fast and accurate, identifying critical control and stability derivatives. The on-line control design must be highly nonlinear and accommodate a full range of hard limits, as well as be computable on-line. In addition, stability and robustness analysis of an adaptive system must be made to ensure the system can be flight certified. In the following sections, only the efforts sponsored at WL will be discussed.

Derived from text

*Automatic Flight Control; Adaptive Control; Parameter Identification; Control Systems Design*

## 09

### RESEARCH AND SUPPORT FACILITIES (AIR)

*Includes airports; hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.*

19990014569 Virginia Transportation Research Council, Charlottesville, VA USA

Evaluating Improvements in Landside Access for Airports *Final Report*

Hoel, Lester A., Virginia Transportation Research Council, USA; Shriner, Heather Wishart, Virginia Transportation Research Council, USA; Oct. 1998; 92p; In English

Contract(s)/Grant(s): SPR 5750-040-940

Report No.(s): PB99-113276; FHWA/VTRC-99-R7; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The purpose of this research is to describe the elements that comprise airport access and to develop a methodology for identifying and evaluating existing landside access performance and proposed improvements from a passenger perspective. The scope is limited to landside access service between approaches to the airport and the terminal entrance. Approaches refer to the major materials, freeways, or rapid transit facilities that provide access to and from the airport. Parking, terminal curbside, and public

transportation concerns are addressed as well. Passenger travel is the focus of this research. Employee, cargo, and urban traffic components are studied to determine their effect on passenger access.

NTIS

*Airports; Passengers; Terminal Facilities; Urban Transportation*

## 10 ASTRONAUTICS

*Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications; spacecraft communications; command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.*

19990014374 Advisory Group for Aerospace Research and Development, Propulsion and Energetics Panel, Neuilly-Sur-Seine, France

*Pulse Detonation Wave Engine*

Edelman, Raymond, Advisory Group for Aerospace Research and Development, France; Henderson, Robert E., Editor, Advisory Group for Aerospace Research and Development, France; *Aerospace* 2020, Sep. 1997; Volume 3, pp. 91-93; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Tactical missiles based on Pulse Detonation Wave Engines (PDEs) have the potential of increased range, enhanced survivability, lower cost, and reduced time of flight. The advantages derive from two overall features of the intermittent combustion device compared to competing steady flow engines. The first feature is the quasi-constant volume characteristic of the detonative combustion process with theoretical increases of the specific impulse and the thermodynamic cycle efficiency. The second feature is related to a simple design which combines compression, combustion, and thrust production in one component. The paper discusses various missile applications of the detonation based cycle, several design issues, and R&D needs which have to be resolved to take full advantage of the PDE.

Author

*Detonation Waves; Missile Systems; Pulsejet Engines; Design Analysis*

## 12 ENGINEERING

*Includes engineering (general); communications and radar; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.*

19990014060 Clarkson Univ., Electrical and Computer Engineering Dept., Potsdam, NY USA

*Report 1: Basic Operation of the Switched Reluctance Motor*

Pillay, Pragasen, Clarkson Univ., USA; [1998]; 8p; In English

Contract(s)/Grant(s): NGT3-52335; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Typically salient poles have windings forming coils wrapped around the waists (or pole cores) of each pole. This is true for the stator of the SRM but not for the rotor. The rotor has no windings, no coils, no magnets, no commutator, or slip rings it is only comprised of laminated steel sheets stamped in the shape of the pole design and mounted on a shaft. This allows for ease in manufacturing the rotor as well as reducing the rotor's inertia. There is also no electrical loss associated with the rotor since there are no windings, commutator, or slip rings.

Derived from text

*Shafts (Machine Elements); Rotors; Electric Motors; Switching; Magnets; Design Analysis*

19990014056 Toledo Univ., Dept. of Mechanical, Industrial and Manufacturing Engineering, OH USA

*Application of Aeroelastic Solvers Based on Navier-Stokes Equations. Final Report, 21 Dec. 1994 - 21 Jan. 1997*

Keith, Theo G., Jr., Toledo Univ., USA; Srivastava, Rakesh, Toledo Univ., USA; Dec. 1998; 5p; In English

Contract(s)/Grant(s): NAG3-447; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

A pre-release version of the Navier-Stokes solver (TURBO) was obtained from MSU. Along with Dr. Milind Bakhle of the University of Toledo, subroutines for aeroelastic analysis were developed and added to the TURBO code to develop versions 1 and 2 of the TURBO-AE code. For specified mode shape, frequency and inter-blade phase angle the code calculates the work done

by the fluid on the rotor for a prescribed sinusoidal motion. Positive work on the rotor indicates instability of the rotor. The version 1 of the code calculates the work for in-phase blade motions only. In version 2 of the code, the capability for analyzing all possible inter-blade phase angles, was added. The version 2 of TURBO-AE code was validated and delivered to NASA and the industry partners of the AST project. The capabilities and the features of the code are summarized in Refs. [1] & [2]. To release the version 2 of TURBO-AE, a workshop was organized at NASA Lewis, by Dr. SRivastava and Dr. M. A. Bakhle, both of the University of Toledo, in October of 1996 for the industry partners of NASA Lewis. The workshop provided the potential users of TURBO-AE, all the relevant information required in preparing the input data, executing the code, interpreting the results and bench marking the code on their computer systems. After the code was delivered to the industry partners, user support was also provided. A new version of the Navier-Stokes solver (TURBO) was later released by MSU. This version had significant changes and upgrades over the previous version. This new version was merged with the TURBO-AE code. Also, new boundary conditions for 3-D unsteady non-reflecting boundaries, were developed by researchers from UTRC, Ref. [3]. Time was spent on understanding, familiarizing, executing and implementing the new boundary conditions into the TURBO-AE code. Work was started on the phase lagged (time-shifted) boundary condition version (version 4) of the code. This will allow the users to calculate non-zero interblade phase angles using, only one blade passage for analysis.

Author

*Navier-Stokes Equation; Aeroelasticity; Phase Shift; Pitch (Inclination); Rotors; Vibration Mode; Thermoelasticity; Unsteady Aerodynamics*

19990014324 Toledo Univ., Dept. Mechanical, Industrial and Manufacturing Engineering, OH USA

Development of an Aeroelastic Analysis Including a Viscous Flow Model *Final Report, 23 Jan. 1996 - 31 Oct. 1997*

Keith, Theo G., Jr., Toledo Univ., USA; Bakhle, Milind A., Toledo Univ., USA; Dec. 1998; 3p; In English

Contract(s)/Grant(s): NAG3-1803; No Copyright; Avail; CASI; A01; Hardcopy; A01; Microfiche

Under this grant, the flutter versions of the three-dimensional Navier-Stokes aeroelastic code (TURBO-AE) have been developed. The TURBO-AE aeroelastic code allows flutter calculations for a fan, compressor, or turbine blade row. This code models a vibrating three-dimensional bladed disk geometry and the associated unsteady flow (including shocks, and viscous effects) to calculate the aeroelastic instability using a work-per-cycle or eigenvalue approach. Steady and unsteady calculations have been performed with the 3D Navier-Stokes (TURBO) code to gain familiarity with the code. Calculations were done with the NASA Rotor-67 configuration which has been used as a standard test case by turbomachinery researchers. Additional calculations have been performed for the NASA/GE EEE fan and a proprietary configuration.

Derived from text

*Aeroelasticity; Viscous Flow; Navier-Stokes Equation; Flutter; Rotor Aerodynamics; Rotor Dynamics; Mathematical Models*

19990014379 Advisory Group for Aerospace Research and Development, Structures and Materials Panel, Neuilly-Sur-Seine, France

*Low Cost Manufacturing*

Johnson, Verner J., Advisory Group for Aerospace Research and Development, France; Holzwarth, Richard C., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, pp. 121-125; In English; Also announced as 19990014353; Copyright Waived; Avail; CASI; A01; Hardcopy; A02; Microfiche

Several specific technologies relating to design approaches, design concepts, and manufacturing processes are being developed now that will lead to more integrated structure for future airframes. Unitized aircraft structures will be combinations of advanced composite and metallic structures that allow for designs with reduced numbers of fabricated parts and assembly steps. Material selection will be made on the basis of load condition and intensity, temperature range, specific strength, specific cost, or critical factors based on structural application. Low cost manufacturing will be influenced primarily by design, with no single material system or manufacturing process being the preferred path. Design concepts that emphasize more unitized structure are synergistic with manufacturing processes that emphasize fabrication of articles that are virtually the finished product. Systems integration issues are major players to achieving low cost manufacturing, and new approaches to design and manufacturing of these subsystems are critical.

Derived from text

*Low Cost; Manufacturing; Systems Integration; Aircraft Structures; Aircraft Production Costs*

## 13 GEOSCIENCES

*Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.*

19990017667 Johns Hopkins Univ., Applied Physics Lab., Laurel, MD USA  
Near Earth Asteroid Rendezvous Flight Battery Performance

Jenkins, Jason E., Johns Hopkins Univ., USA; Hayden, Jeff W., Eagle-Picher Industries, Inc., USA; Pickett, David F., Eagle-Picher Industries, Inc., USA; The 1997 NASA Aerospace Battery Workshop; Jul. 1998, pp. 113-147; In English; Also announced as 19990017662; No Copyright; Avail: CASI; A03, Hardcopy; A10, Microfiche

Topics discussed include the following: Background and flight observation; System/Mission design; Battery charging; Battery description and design; Thermal bias regime; Flight thermal bias observation; Mission simulation test; Trickle charge; Test battery reconfiguration; Battery capacity measurement; Battery capacity discharge; and Explanation of events.

Derived from text

*Asteroid Missions; Electric Batteries; Systems Engineering; Flight Characteristics*

## 14 LIFE SCIENCES

*Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology*

19990014354 Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, Neuilly-Sur-Seine, France  
Drawing on Today's Wise Investments: Longitudinal and Baseline Human-Resource Research

King, R. E., Advisory Group for Aerospace Research and Development, France; McGlohn, S. E., Advisory Group for Aerospace Research and Development, France; Retzlaff, P. D., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, pp. 3-6; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche

Many of the pilots who will be flying in the year 2020 are just now being born or are currently very young children. We will know more about these pilots than we presently know about our current pilots. The air forces of the future will surely include many more women as they will likely compete on an equal footing and may be represented in all cockpits. Efforts currently underway, including Neuropsychiatrically Enhanced Flight Screening, Assessment of Psychological Factors in Aviators and Psychological Factors of Aviators' Success may bear fruit and answer the question of whether female pilots self-select into aviation or if they are shaped as a result of the process of pilot training. The year 2020 may see the Armstrong Laboratory Aviator Personality Survey as a well established test for use with aviators, with international norms. As we invest increasingly large amounts of money into each individual airframe and mission, we must learn more about the human operator, whether that individual is a pilot or a controller of a pilotless aircraft or spacecraft (Uninhabited Aerial Vehicle).

Author

*Human Resources; Aircraft Pilots; Personnel Development; Human Performance*

19990014371 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France  
Integration of Technologies for Closed Cockpits

Timmers, H., Advisory Group for Aerospace Research and Development, France; Helps, K., Advisory Group for Aerospace Research and Development, France; Aerospace 2020; Sep. 1997; Volume 3, pp. 78; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI; A01, Hardcopy; A02, Microfiche; Abstract Only; Abstract Only

All future aerial missions are threatened by directed energy weapons (DEWS) or flash devices. The availability of rather inexpensive blinding flash devices can soon significantly hinder or even prevent the effective use of air power. In order to protect aircrews and enable them to successfully continue the mission the concept of closed cockpits will be an important means to overcome these threats. Processing capabilities which will be available in the near to midterm future make the realization of closed cockpits feasible. Still, the closed cockpit impose some severe problems which must be solved in order to maintain crew awareness under all circumstances and in all phases of flight. To name only a few of them, problems associated with synthetic vision, sensor displays and sensor integration or pilot interaction with all aircraft systems must be solved to make the closed cockpit concept operational viable. It must be proven, that sensors can be built, which work reliably under all conditions (including massive concider measures), that all available data can be fused together and that all these sensors can be integrated in a way to give results which can be trusted and effectively communicated to the aircrew. The realization of closed cockpits is a task, which requires contributions from many

other technology fields, hence, it works as a technology driver also outside its direct field of application. The benefits of the closed cockpit will be the ability to perform aerial missions also in presence of a new class of threats successfully.

Author

*Cockpits; Pilot Support Systems; Multisensor Fusion; Systems Integration; Flight Management Systems*

19990017762 Army Aeromedical Research Lab., Fort Rucker, AL USA

The Efficacy of Dexedrine for the Sustainment of Helicopter Pilot Performance During 64 Hours of Continuous Wakefulness. *Final Report*

Caldwell, J. A.; Smythe, N. K.; DeDuc, P. A.; Prazinko, B. F.; Caldwell, J. L.; Oct. 1998, 68p. In English

Contract(s)/Grant(s): Proj-3MH62787A879

Report No.(s): AD-A356084; USAARL-TR-99-01; No Copyright; Avail: CASI; A04; Hardcopy; A01; Microfiche

The purpose of this investigation was to establish the efficacy of Dexedrine for sustaining aviator performance despite 64-hours of extended wakefulness. Although earlier flight studies yielded favorable results with no significant side effects, they were restricted to sleep-deprivation periods of only 40 hours. Due to requirements for longer periods of sustained wakefulness, it was necessary to study the efficacy of Dexedrine for maintaining aviator performance during 3 days and 2 nights without sleep. To accomplish this, computerized evaluations of aviator flight skills were conducted at regular intervals as subjects completed standardized flights in a UH-60 helicopter simulator, both under Dexedrine and placebo. Laboratory-based assessments of cognitive, psychological, and central nervous system status were completed as well. Dexedrine (10 mg) was given prophylactically (prior to signs of fatigue) at midnight, 0400, and 0800 on both deprivation days in one cycle, and placebo was given on both days in the other. Results indicated simulator flight performance was maintained by Dexedrine for up to 58 hours, while performance under placebo rapidly deteriorated. The drug was most beneficial

DTIC

*Drugs; Amphetamines; Effectiveness; Helicopter Performance; Research; Aircraft Pilots; Human Performance*

## 15

### MATHEMATICAL AND COMPUTER SCIENCES

*Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics*

19990014059 NASA Langley Research Center, Hampton, VA USA

Global Artificial Boundary Conditions for Computation of External Flow Problems with Propulsive Jets. *Final Report*

Tsyankov, Semyon, Institute for Computer Applications in Science and Engineering, USA; Abarbanel, Saul, Institute for Computer Applications in Science and Engineering, USA; Nordstrom, Jan, Institute for Computer Applications in Science and Engineering, USA; Ryabenkii, Viktor, Institute for Computer Applications in Science and Engineering, USA; Vatsa, Veer, NASA Langley Research Center, USA; Nov. 1998; 24p. In English

Contract(s)/Grant(s): NAS1-97046; RTOP 505-90-52-01

Report No.(s): NASA/CR-1998-208746; NAS 1.26-208746; ICASE-98-52; No Copyright; Avail: CASI; A03; Hardcopy; A01; Microfiche

We propose new global artificial boundary conditions (ABC's) for computation of flows with propulsive jets. The algorithm is based on application of the difference potentials method (DPM). Previously, similar boundary conditions have been implemented for calculation of external compressible viscous flows around finite bodies. The proposed modification substantially extends the applicability range of the DPM-based algorithm. In the paper, we present the general formulation of the problem, describe our numerical methodology, and discuss the corresponding computational results. The particular configuration that we analyze is a slender three-dimensional body with boat-tail geometry and supersonic jet exhaust in a subsonic external flow under zero angle of attack. Similarly to the results obtained earlier for the flows around airfoils and wings, current results for the jet flow case corroborate the superiority of the DPM-based ABC's over standard local methodologies from the standpoints of accuracy, overall numerical performance, and robustness.

Author

*Computational Fluid Dynamics; Airfoils; Boundary Conditions; Jet Exhaust; Jet Flow; Subsonic Flow; Supersonic Jet Flow; Three Dimensional Bodies; Zero Angle of Attack*

19990014372 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France  
Commanders' Decision Aid for Battle Planning and Execution

vandenBroek, P., Advisory Group for Aerospace Research and Development, France; Aerospace 2020, Sep. 1997; Volume 3, pp. 79-82; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI, A01, Hardcopy; A02, Microfiche

Powerful computing equipment will enable the prediction of the evolution of a complex process such as a battle mission, and much faster than real time. This will be used to evaluate the effects of changes in battle plans, both changes in battle tactics and changes in allocated assets. Information networks, mission simulation and virtual reality technology will relieve the commander from much work by the presentation of any desired type of information in any quantity to the commander, but it should be kept in mind that all the decisions remain the full responsibility of the commander himself. The system, however sophisticated, has to provide all the possibilities to live up to this responsibility.

Author

*Decision Support Systems; Real Time Operation; Mission Planning; Flight Simulation; Decision Making; Virtual Reality*

## 16 PHYSICS

*Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy; optics; plasma physics; solid state physics; and thermodynamics and statistical physics.*

19990017743 NASA Langley Research Center, Hampton, VA USA

Ducted-Fan Engine Acoustic Predictions Using a Navier-Stokes Code

Rumsey, C. L., NASA Langley Research Center, USA; Biedron, R. T., NASA Langley Research Center, USA; Farassat, F., NASA Langley Research Center, USA; Spence, P. L., Lockheed Martin Engineering and Sciences Co., USA; Journal of Sound and Vibration, 1998; ISSN 0022-460X; Volume 213, No. 4, pp. 643-664; In English; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

A Navier-Stokes computer code is used to predict one of the ducted-fan engine acoustic modes that results from rotor-wake/stator-blade interaction. A patched sliding-zone interface is employed to pass information between the moving rotor row and the stationary stator row. The code produces averaged aerodynamic results downstream of the rotor that agree well with a widely used average-passage code. The acoustic mode of interest is generated successfully by the code and is propagated well upstream of the rotor, temporal and spatial numerical resolution are fine enough such that attenuation of the signal is small. Two acoustic codes are used to find the far-field noise. Near-field propagation is computed by using Eversman's wave envelope code, which is based on a finite-element model. Propagation to the far field is accomplished by using the Kirchhoff formula for moving surfaces with the results of the wave envelope code as input data. Comparison of measured and computed far-field noise levels show fair agreement in the range of directivity angles where the peak radiation lobes from the inlet are observed. Although only a single acoustic mode is targeted in this study, the main conclusion is a proof-of-concept. Navier Stokes codes can be used both to generate and propagate rotor-stator acoustic modes forward through an engine, where the results can be coupled to other far-field noise prediction codes.

Author

*Navier-Stokes Equation; Acoustic Properties; Ducted Fan Engines; Noise Prediction; Mathematical Models; Rotor Stator Interactions*

## 17 SOCIAL SCIENCES

*Includes social sciences (general); administration and management; documentation and information sciences; economics and cost analysis; law; political science; and space policy; and urban technology and transportation.*

19990014362 Advisory Group for Aerospace Research and Development, Mission Systems Panel, Neuilly-Sur-Seine, France  
Information Correlation Fusion

Onken, R., Advisory Group for Aerospace Research and Development, France; Dewey, D., Advisory Group for Aerospace Research and Development, France; Aerospace 2020, Sep. 1997; Volume 3, pp. 55-58; In English; Also announced as 19990014353; Copyright Waived; Avail: CASI, A01, Hardcopy; A02, Microfiche

A definition of Information Correlation/Fusion (IC/F), reasons for using IC/F, application of IC/F to Unmanned Tactical Aircraft (UTA), application of IC/F to mission management, improvements needed by 2020 in IC/F for UTA's, improvements needed by 2020 in IC/F for mission management and other supporting technologies needed by 2020 are presented.

CASI

*Multisensor Fusion; Pilotless Aircraft; Data Management*

# Subject Term Index

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